SPECIFICATION

Heat release sheet and heat sink

FIELD OF THE INVENTION

The present invention concerns a heat release sheet and a heat sink for efficiently release heat which generates in a CPU used in an electronic equipment such as a notebook computer and a portable telephone, a semiconductor part such as a power transistor and a plasma display panel of a plasma television, and other heat generating devices such as silicon microprocessors, light emitting diodes (LED) and/or organic light emitting diodes (OLED).

BACKGROUND OF THE INVENTION

Recently, the electronic equipment such as the notebook computer and the portable telephone used in our daily life are technically advantaged and miniaturized at short term.

Based on performance enhancement and miniaturization such the electronic equipment, capacity enlargement and high integration of the semiconductor parts included in inside of the electronic equipment are promoted, and heat value in inside of the electronic equipment increases more.

Conventionally, in the electronic equipment such as the notebook computer, heat generation from the semiconductor parts is transferred to a fin and a heat sink through a metal plate such as copper and aluminum etc. that are well heat conductivity, and the heat is released to outside, but in recent years, a graphite sheet is used instead of the metal plate (for example, see the reference 1).

The reason is that compared to copper or aluminum, in-plane heat conductivity of the graphite sheet is high, (twice of copper and three times of aluminum), and the graphite sheet has an excellent property that low price and lightness in weight.

The graphite sheet is used as a heat release sheet that intervenes between substrates in a multilayer substrate comprised of a circuit board of multiple layers, and the heat release sheet of the plasma display panel in the plasma television.

The graphite sheet is made from a layer structure of carbon. An in-plane direction molecule of each layer is bonded firmly by covalent bond. Since a direction (direction to thickness) which is orthogonalized with a plane direction is weak combination by intermolecular force, there is a problem that interlaminar abruption easily occurs.

Although the graphite sheet is excellent in the heat conductivity to the in-plane direction, since the heat conductivity of a direction which is orthogonalized (direction to thickness) with the plane direction is low, there is a case that heat release effect is not sufficiently obtained.

As a prior art, a heat release sheet that copper powder is compounded into graphite is also known.

In the prior art's heat release sheet, although the heat conductivity of a direction which is orthogonalized (direction the thickness) with the plane direction is not enough, the heat conductivity can be increased. However, a problem of

interlaminar abruption that is worst weakness of the heat release sheet cannot be dissolved.

Generally, the heat sink is made from aluminum and copper etc., but the heat release effect to the heat generated from these metal has a limit, and recently, it cannot sufficiently deal with the increasing of heat value based on progress of capacity enlargement and high integration of semiconductor parts.

The heat sink using graphite is provided (for example, see the reference 2), but the heat sink has same problem with said heat sink that interlaminar abruption easily occurs and a direction which is orthogonalized (direction to thickness) with the plane direction is low. The heat release effect cannot be obtained enough.

Conventionally, as a sheet for shielding electromagnetic wave generating from each component of an electronics device, the sheet compounding a magnetic material in plastic is known. However, heat conductance of this conventional sheet is low, and enough heat radiation effect cannot be obtained.

Reference 1 Official gazette of Tokukai2003-168882

Reference 2 Official gazette of Tokukai2003-60140

The present invention is invented so as to dissolve above-mentioned prior art's problems, and its purpose is to provide a heat release sheet and a heat sink having excellent heat conductivity to both of plane direction and orthogonalized direction. The heat release sheet and the heat sink can efficiently release

heat generating from a notebook computer and a plasma television etc. Further, they can be used as a high quality sheet for shielding electromagnetic wave.

SUMMARY OF THE INVENTION

The invention concerning claim 1 relates a heat release sheet comprised of an expansive graphite sheet and a reticulated body, wherein said reticulated body is comprised of metal wire, and it is overlapped on both sides of said expansive graphite sheet, and said expansive graphite sheet and said reticulated body are combined.

The invention concerning claim 2 relates the heat release sheet described in claim 1, wherein said reticulated body is bursiform configuration, and said expansive graphite sheet is inserted in the bursiform configuration.

The invention concerning claims 3 and 4 relates the heat release sheet described in claims 1 or 2, wherein said expansive graphite sheet is comprised of plural sheets, and a reticulated intermediate comprised of the metal wire is intervened between said plural expansive graphite sheets.

The invention concerning claims 5 and 6 relates the heat release sheet described in claims 1 or 2, wherein said expansive graphite sheet is comprised of plural sheets, and a metallic foil having many protrusions on its both sides is intervened between said plural expansive graphite sheets.

The invention concerning claims 7 to 12 relates the heat release sheet described in either one of claims 1 to 6, wherein said expansive graphite sheet and the reticulated body are laminated and combined by metal rolling processing.

The invention concerning claim 13 to 18 relates the heat release sheet described in either one of claims 1 to 6, wherein said reticulated body is comprised by knit processing of the metal wire.

The invention concerning claims 19 to 24 relates the heat release sheet described in either one of claims 1 to 6, wherein said reticulated body is comprised by weave processing of the metal wire.

The invention concerning claims 25 to 30 relates the heat release sheet described in either one of claims 1 to 6, wherein plural said reticulated bodies are laminated at least one side of said expansive graphite sheet.

The invention concerning claims 31 to 36 relates the heat release sheet described in either one of claims 1 to 6, wherein surface of said reticulated body is covered with resin in at least one side of said expansive graphite sheet.

The invention concerning claims 37 to 42 relates the heat release sheet described in either one of claims 31 to 36, wherein a protective layer comprised of a synthetic resin film is applied on a surface of said resin layer.

The invention concerning claims 43 to 48 relates the heat release sheet described in either one of claims 1 to 6, wherein said

combined expansive graphite sheet and said reticulated body are washed with reduction water.

The invention concerning claims 49 to 61 relates a heat sink which is obtained by fabricating of the heat release sheet described in either one of claims 1 to 7, 13, 19, 25, 31, 37 and 43.

Since the present invention of claim 1 is comprised by laminating and combining the reticulated body comprised of the metal wire on both sides of the expansive graphite sheet, the both sides of expansive graphite sheet are held tight by the reticulated body, and interlaminar abruption of the graphite is difficult to occur. Further, since heat conduction to the thickness direction occurs through the reticulated body comprising of the metal wire, the heat conduction to direction to thickness is excellent.

Therefore, the heat release sheet which can efficiently release heat generating in a CPU used in an electronic equipment such as a notebook computer and a portable telephone, a semiconductor parts such as a power transistor and a plasma display panel of a plasma television etc can be obtained. Further, by laminating and combining the reticulated body comprised of the metal wire on a graphite sheet having high shielding effect of electromagnetic wave, the effect can be improved. Therefore, the invention can be used effectively as a sheet for shielding electromagnetic wave generating from an electronics device.

Since the present invention of claim 2 is comprised that the reticulated body is bursiform configuration, and the expansive

graphite sheet is inserted in the bursiform configuration, a separation of the expansive graphite sheet and the reticulated body is prevented, and the expansive graphite sheet and the reticulated body can certainly be combined.

Since the present invention of claims 3 and 4 is comprised that the expansive graphite sheet is comprised of plural sheets, and a reticulated intermediate comprised of the metal wire is intervened between the plural expansive graphite sheets, high sheet strength can obtained, and the interlaminar abruption can certainly be prevented.

Since the present invention of claims 5 and 6 is comprised that the expansive graphite sheet is comprised of plural sheets, and a metallic foil having many protrusions on its both sides is intervened between the plural expansive graphite sheets, high sheet strength can obtained, and the interlaminar abruption can certainly be prevented.

Since the present invention of claims 7 to 12 is comprised that the expansive graphite sheet and the reticulated body are laminated and combined by metal rolling processing, the reticulated body can be buried in the expansive graphite sheet, and there surfaces can be in same surface, and thickness of the sheet can be reduced. The interlaminar abruption of graphite is more difficult to occur, and heat conductivity to direction to thickness can be increased more.

Since the present invention of claims 13 to 18 is comprised

that the reticulated body is comprised by knit processing of the metal wire, flexibility of the reticulated body can be excellent, and also thickness of the reticulated body can be increased. Therefore, the heat release sheet that is thin and excellent in flexibility can be obtained.

Since the present invention of claims 19 to 24 is comprised that the reticulated body is comprised by weave processing of the metal wire, bond strength of each metal wire in the reticulated body is excellent. Therefore, the heat release sheet that a break of reticulated body is difficult to occur can be obtained.

Since the present invention of claims 25 to 30 is comprised that plural reticulated bodies are laminated at least one side of the expansive graphite sheet, the interlaminar abruption of graphite is more difficult to occur, and heat conductivity to direction to thickness can be increased more.

Since the present invention of claims 31 to 36 is comprised that surface of said reticulated body is covered with resin layer in at least one side of said expansive graphite sheet, desorption of graphite powder from the surface of the sheet and desorption of the reticulated body from the expansive graphite sheet can be prevented. Further thickness of the heat release sheet can be easily adjusted.

Since the present invention of claims 37 to 42 is comprised that the heat release sheet described in claims 1 to 36, wherein a protective layer comprised of a synthetic resin film is applied on a

surface of said resin layer, in case of the protective layer is applied between the semiconductor parts and the expansive graphite sheet, when heat of parts passes with winding or diffusing in the synthetic resin film, the heat is transmitted to the expansive graphite sheet, and the heat release effect is improved.

Since the present invention of claims 43 to 48 is comprised that the heat release sheet described in either one of claims 1 to 42, wherein said combined expansive graphite sheet and said reticulated body are washed with reduction water, adhesion of the refuse by electrification of static electricity is also prevented. Therefore, the heat release sheet which is suitable for fixing in an electronic equipment can be obtained.

Since the present invention of claims 49 to 61 is comprised that a heat sink, wherein obtained by fabricating of the heat release sheet described in either one of claims 1 to 48, interlaminar abruption of the graphite is difficult to occur. Further, since heat conduction to the direction to thickness occurs through the reticulated body comprised of the metal wire, the heat conduction to the thickness direction is excellent.

Therefore, the heat release sheet which can efficiently release heat generating in a CPU used in an electronic equipment such as a notebook computer and a semiconductor parts such as a power transistor.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view showing an example of a heat release sheet concerning he present invention.

Figure 2 is an exploded perspective view showing an example of a heat release sheet concerning the present invention.

Figure 3 is a plan view showing a reticulated body and showing a sheet type reticulated body by knit processing of a metal wire.

Figure 4 is a plan view showing other example of the reticulated body and showing a sheet type reticulated body by weave processing of a metal wire.

Figure 5 is a pattern cross sectional view showing an example of a heat release sheet concerning the present invention.

Figure 6 is an exploded perspective view showing an application example of a heat release sheet concerning the present invention.

Figure 7 is a pattern cross sectional view showing the application example of a heat release sheet concerning the present invention.

Figure 8 is a pattern cross sectional view showing the application example of a heat release sheet concerning the present invention.

Figure 9 is a pattern cross sectional view showing the application example of a heat release sheet concerning the present invention.

Figure 10 is a pattern cross sectional view showing the application example of a heat release sheet concerning the present invention.

Figure 11 is a view showing other application example of a heat release sheet concerning the present invention.

Figure 12 is a view showing other application example of a heat release sheet concerning the present invention.

Figure 13 is a view showing other application example of a heat release sheet concerning the present invention.

Figure 14 is a view showing a heat sink concerning the present invention.

Figure 15 is a schematic view showing a use of the heat release sheet and the heat sink.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, the heat release sheet and the heat sink concerning the present invention are explained with referring to drawings.

Fig 1 is a perspective view showing an example of a heat release sheet concerning the present invention, and Fig. 2 is an its exploded perspective view.

The heat release sheet concerning the present invention is comprised by overlapping a reticulated body (2) comprised of a metal wire to both sides of an expansive graphite sheet (1) and by combining the expansive graphite sheet (1) and the reticulated body (2).

As a combining method of the expansive graphite sheet (1) and the reticulated body (2), a metal rolling processing is suitably used, but other method such as a using of adhesive agent etc can be employed.

At first, the expansive graphite sheet (1) is made by reacting graphite powder such as natural graphite, pyrolytic graphite and kish graphite with concentrated sulfuric acid and concentrated nitric acid solution etc, and they changes to an interlaminar compound. Then the compound is changed to a residual compound through residual dissolution by water washing.

An expansive graphite obtained by expanding the residual compound by rapidly heating is compression molded with using a roll material, and a sheet type expansive graphite sheet (1) having flexibility is made and suitably used.

Thickness of the expansive graphite sheet (1) is not limited particularly, but the thickness of 0.10~1.5 mm is preferably. When the thickness is under 0.10 mm, enough sheet strength is not obtained, and the expansive graphite sheet may break when metal rolling and combining with overlapping the reticulated body (2), and further, when the thickness is over 1.5 mm, interlaminar abruption easily occurs, and heat conductivity to the direction to the thickness and flexibility decreases, and both cases are not preferably.

Density of the expansive graphite sheet (1) is not limited particularly, but about 0.80~2.2 g/cm^3 is preferably. When the density is under 0.80 g/cm^3, the heat conductivity and the sheet strength decreases, and further, when the density is over 2.2 g/cm^3, flexibility decreases, and both cases are not preferably.

As materials of the metal wire which comprises the

reticulated body (2), a metal having high coefficient of thermal conductivity is preferably used. For example, copper, stainless steel, platinum, titanium, aluminum, Inconel, Monel metal and nickel etc, or alloy of these metals can be exemplified, but the metal wire is not limited to these materials.

Depend on the thickness of expansive graphite sheet (1), thickness of the metal wire which comprises the reticulated body (2) can be set properly. In case of the thickness of the expansive graphite sheet is set as 1, the metal wire having diameter 0.1~0.5, more preferably 0.2~0.3 can be used suitably.

Largeness of the reticulated body (2) is not limited particularly, it is desirable to have same pattern mesh 5~40 in an area of 10 mm × 10 mm. When the mesh is too large, preventing effect of interlaminar abruption and the heat conductivity of direction to the thickness decreases. When the mesh is too small, the flexibility decreases with increasing weight, and both cases are not preferably.

As the reticulated body (2), as shown in Fig. 3, a sheet-like metal wire which is knit processed is suitably used, but as shown in Fig. 4, a sheet-like metal wire which is weave processed can be used. Further, a sheet-like reticulated body of the metal wire which is processed except for the knit processing and the weave processing can also be used.

As the knit processing, welt knit processing such as plain stitch, rib stitch, purl stitch, tuck stitch, float stitch, half cardigan,

full cardigan, plating stitch and interlock stitch can be used. Further, as the knit processing, warp processing such as single tricot stitch, double tricot stitch, lace stitch, milanese stitch can be used.

By using the knit processed metal wire as the reticulated body (2), its flexibility is excellent, and thickness can be thin. As a result, the heat release sheet which is thin and excellent in flexibility can be obtained.

As weave processing, plain weave, twill weave, satin weave, combination weave, gauze & leno weave and jacquard weave can be used.

By using the weave processed metal wire as the reticulated body (2), its bond strength is excellent. The heat release sheet that a damage of the reticulated body is difficult to be generated is obtained.

The reticulated body (2) made from said metal wire is combined with overlapping both sides of said expansive graphite sheet (1). The combining method is not limited particularly, a metal rolling processing method by a metal rolling roll can be used.

Fig. 5 is a pattern cross sectional view showing an example of a heat release sheet comprised of the expansive graphite sheet (1) and the reticulated body (2) combined by the metal rolling processing.

As shown in Fig. 5, the metal wire which comprises the reticulated body (2) buries respectively in both sides of the

expansive graphite sheet (1) by metal rolling processing. The reticulated body (2) and the expansive graphite sheet (1) are in same surface.

Further, in Fig. 5, the reticulated body (2) and the expansive graphite sheet (1) are in same surface completely, but the reticulated body (2) can protrude from a surface of the expansive graphite sheet (1), but it is better that a protrusion amount is less.

By burring the metal wire which comprises the reticulated body (2) in both sides of the expansive graphite sheet (1) by metal rolling processing, the expansive graphite sheet (1) is holed tightly by the reticulated body (2), the interlaminar abruption of graphite is difficult to be occur. Further, heat conduction to thickness direction occurs through the reticulated body (2) comprised of the metal wire, the heat conduction to the direction to the thickness is excellent.

In the present invention, the different reticulated body (2) can be used in adverse side and backside of the expansive graphite sheet (1). To be more precise, in adverse side and backside of the expansive graphite sheet (1), largeness of the mesh of the reticulated body (2), a forming method (knit processing or weave processing) of the reticulated body (2), kind and/or diameter of metal wire comprises the reticulated body (2) can be differed in adverse side and backside of the expansive graphite sheet (1).

Further, in the heat release sheet concerning the present invention, the expansive graphite sheet (1) can be combined by

metal rolling processing with laminating plural reticulated body (2) at either adverse side or backside of the expansive graphite sheet (1).

Fig. 6 is an exploded perspective view showing of the heat release sheet comprised of laminating two sheets reticulated body (2) in both sides of the expansive graphite sheet (1). More than three sheets reticulated body (2) can be laminated in both sides respectively. Further, number of laminated reticulated body (2) can be differed in adverse side and backside (for example, two sheets and three sheets, and three sheets and four sheets). Moreover, only one reticulated body (2) is laminated at one side of the expansive graphite sheet (1), and the plural reticulated body (2) can be laminated at other side of the expansive graphite sheet (1) (for example, one sheet and two sheets, and one sheet and three sheets).

In the heat release sheet concerning the present invention, in one side or desirably both sides of the expansive graphite sheet (1), a surface of the reticulated body (2) can be coated by resin.

Fig. 7 and 8 are pattern cross sectional views showing said coating composition of the expansive graphite sheet (1) and the reticulated body (2).

Fig. 7 is an example of coating of a resin layer (3) to adverse side of the reticulated body (2) laminated on both sides of the expansive graphite sheet (1), and Fig. 8 is an example of coating of the resin layer (3) to both sides of the reticulated body (2)

laminated on both sides of the expansive graphite sheet (1). Further, the resin layer (3) can be laminated to backside of the reticulated body (2) (not shown). The coating of the resin layer (3) can be applied to the heat release sheet laminated plural reticulated body (2).

As resin for coating the surface of the reticulated body (2), epoxy resin, silicone resin, phenol resin, varnish, enamel and PTFE resin can be exemplified. By covering the surface of the reticulated body (2) by said resin, desorption of graphite powder from the surface of the heat release sheet and desorption of the reticulated body from the expansive graphite sheet can be prevented. Further thickness of the heat release sheet can be adjusted.

The thickness of the resin layer (3) is not limited particularly, and 0.001~1.2 mm is desirable. When the thickness of the resin layer (3) is under 0.001 mm, enough covering effect may not be obtained, and when the resin layer (3) is over 1.2 mm, covering effect does not increase, and the heat conductivity and the flexibility may decrease.

As a covering method, a well known covering method can be used, for example, the resin layer (3) is baked after a dipping.

In the present invention, as shown in Fig. 9 and 10, a protective layer (4) comprised of a synthetic resin film, which can be abruption or cannot be abruption can be located on a surface of the resin layer (3).

Fig. 9 shows a view that the resin layer (3) is covered on adverse surface side of the heat release sheet. In this case, the protective layer (4) is covered only the adverse surface side. Fig. 10 shows a view that the resin layer (3) is covered on both sides of the heat release sheet. In this case, also, the protective layer (4) is covered both sides. Further, only the protective layer (4) can be applied without applying the resin layer (3) on adverse side and/or back side (not shown).

As synthetic resin which comprises the protective layer (4), PET (polyethylene terephthalate), polyethylene, polypropylene polyimide, acrylic resin, nylon and polyvinyl chloride can be exemplified. A film comprised of these materials is combined to the resin layer (3) directly or using adhesive.

One example of physicality value of a synthetic resin comprising the protective layer (4) is shown in Table 1.

Table 1

physicality	Specific gravity	tensile strength	elastic modulus of bending	linear expansion coefficient
Unit		MPa	MPa	$\times 10^{-5}$／℃
ASTM test method	D-792	D-638	D-790	D-696
P E T	1.39	84	3011	6.0
polyethylene (high density)	0.96	25	1079	11.0
polyethylene (low density)	0.92	90～110	2000	16～18
polypropylene	0.91	32	1667	11.0
polyimide	1.43	92	3430	3.6.
acrylate resin	1.19	75	3300	7.0
66 Nylon	1.13 ～ 1.15	83	2795	9.0
polyvinylchloride	1.47	55	3300	7.0

Fig. 11~13 are views showing other application example of a heat release sheet concerning the present invention. (a) is a perspective view and (b) is a cross sectional view.

In the heat release sheet as shown in Fig. 11, a bursiform configuration of the reticulated body (2) comprised of the metal wire is formed. By inserting the expansive graphite sheet (1) in the bursiform configuration, the reticulated body (2) is laminated on both sides of the expansive graphite sheet (1). The bursiform configuration which comprises the reticulated body (2) can be opened its one end, or can be opened its both ends.

In the heat release sheet in Fig. 11, the expansive graphite sheet (1) and the reticulated body (2) are laminated and combined. A method for laminating and combining is not limited particularly, and it is desirable that the expansive graphite sheet (1) and the

reticulated body (2) are in same surface with using a metal rolling processing method by the metal rolling roll.

The reticulated body (2) can protrude from the surface of the expansive graphite sheet (1), and it is desirable that amount of the protrusion is few.

In the cross sectional view of Fig. 11 (b), the reticulated body (2) absolutely exposes in the surface of the expansive graphite sheet (1).

The heat release sheet as shown in Fig. 12 is comprised of two sheets of the expansive graphite sheet (1). Between the expansive graphite sheet (1), a sheet type reticulated intermediate (5) comprised of the metal wire is intervened. Further, the reticulated body (2) is laminated and combined on both sides of a configuration of the expansive graphite sheet (1) and the reticulated intermediate (5).

Same composition with the reticulated body (2) is used as the reticulated intermediate (5).

In the figure, number of the expansive graphite sheet (1) is two, but the reticulated intermediate (5) can be intervened in the expansive graphite sheet (1) more than three sheets.

As laminating method of the reticulated body (2) in both sides of the configuration of the expansive graphite sheet (1) and the reticulated intermediate (5), a sheet type reticulated body (2) as shown in Fig. 2 can be overlapped so as to cover the both sides of the configuration. The configuration can be inserted in the

bursiform configuration which comprises the reticulated body that is opened one end or both ends as shown in Fig. 11. In the Fig. 12, latter example is shown.

In the heat release sheet in Fig. 12, the expansive graphite sheet (1), the reticulated body (2) and the reticulated intermediate (5) are laminated and combined. A laminating and combining method is not limited particularly, the metal rolling processing with using the metal rolling roll is desirable.

By the metal rolling processing, it is desirable that the metal wire which comprises the reticulated body (2) and the reticulated intermediate (5) buries respectively in both sides of the expansive graphite sheet (1) by metal rolling processing, and the expansive graphite sheet (1), the reticulated body (2) and the reticulated intermediate (5) are in same surface.

Further, the reticulated body (2) and the reticulated intermediate (5) can protrude from a surface of the expansive graphite sheet (1), but it is better that a protrusion amount is less.

In the cross sectional view of Fig. 12 (b), the reticulated body (2) and the reticulated intermediate (5) absolutely exposes in the surface of the expansive graphite sheet (1).

The heat release sheet shown in Fig. 13 is comprised of two sheets of the expansive graphite sheet (1), and a metallic foil (6) is intervened between two sheets of the expansive graphite sheet (1). Further, the reticulated body (2) is combined with both sides of configuration of the expansive graphite sheet (1) and the metallic

foil (6).

Fig. 13 (c) is a schematic cross sectional view of the metallic foil (6), as shown in the figure, many protrusions are formed in both sides of the metallic foil (6).

As a kind of metal which comprises the metallic foil (6), copper is most suitable, because of its excellent heat conductivity and low price. Aluminum and other metal can also be used. Thickness of the metallic foil (6) is preferably 0.05~0.2 mm, and thickness of about 0.1 mm is most preferable.

In the figure, number of the expansive graphite sheet (1) is two, but the metallic foil (6) can be intervened in expansive graphite sheet (1) more than three sheets. As laminating method of the reticulated body (2) in both sides of the configuration of the expansive graphite sheet (1) and the metallic foil (6), a sheet type reticulated body (2) as shown in Fig. 2 can be overlapped so as to cover the both sides of the configuration. The configuration can be inserted in the bursiform configuration which comprises the reticulated body that is opened one end or both ends as shown in Fig. 11. In the Fig. 13, latter example is shown.

In the heat release sheet in Fig. 13, the expansive graphite sheet (1), the reticulated body (2) and the metallic foil (6) are combined. A method for combining is not limited particularly, it is desirable that the expansive graphite sheet (1), the reticulated body (2) and the metallic foil (6) are in same surface with using a method of metal rolling processing by the metal rolling roll.

Further, the reticulated body (2) and the metallic foil (6) can protrude from a surface of the expansive graphite sheet (1), but it is better that a protrusion amount is less.

In the cross sectional view of Fig. 13 (b) the reticulated body (2) and the metallic foil (6) absolutely exposes in the surface of the expansive graphite sheet (1).

In the heat release sheet concerning the present invention shown in Fig. 11~13, in one side or desirably both sides of the expansive graphite sheet (1), a surface of the reticulated body (2) can be coated by resin.

As resin for coating the surface of the reticulated body (2), epoxy resin, silicone resin, phenol resin, varnish, enamel and PTFE resin can be exemplified. By covering the surface of the reticulated body (2) with said resin, desorption of graphite powder from the surface of the heat release sheet and desorption of the reticulated body from the expansive graphite sheet can be prevented. Further thickness of the heat release sheet can be easily adjusted.

As thickness of the resin layer and a resin covering method, same thickness and method as said heat release sheet can be employed.

In all the heat release sheets as mentioned above, a configuration that deterges combined the expansive graphite sheet (1) and the reticulated body (2) with using reduction water can preferably be employed.

The heat release sheet combined the reticulated intermediate (5) and the metallic foil (6) is deterged with using reduction water similarly.

The reduction water has negative oxidation-reduction potential, and the reduction water usually shows alkalinity of about pH 7～10. The value of the oxidation-reduction potential is −200～−800 mV and desirably −600～−800 mV, and for example, it is −650 mV.

Such reduction water has excellent permeation ability stably so that water molecule cluster is smaller than pure water, and also the reduction water has stabilized reduction. Therefore, minute refuse which adhered to the sheet can be surely removed by washing the sheet by reduction water. Further, adhesion of the refuse by electrification of static electricity is also prevented. Therefore, the heat release sheet which is suitable for fixing in an electronic equipment can be obtained.

The producing method of reduction water used in the present invention is not limited particularly, for example, following methods can be exemplified.

1. Gas bubbling method.

By bubbling of nitrogen gas or hydrogen gas, oxygen concentration of underwater is lowering, and the oxidation-reduction potential is lowering.

2. A method by adding hydrazine

By adding hydrazine, oxygen concentration of underwater is

lowering, and the oxidation-reduction potential is lowering.

3. A method by electrolysis

(a) Water is electrolyzed by impression of asymmetry high frequency voltage which pulse height value of positive and negative and/or duty ratio, and the oxidation-reduction potential is lowering.

(b) An electrode is comprised from a special shape electrode (rhombic and reticular electrode or hexagon reticular electrode) comprised of two sheets of Pt and Ti that one grand electrode (cathode electrode), anode electrode and cathode electrode alternately changes, and water is electrolyzed by impression of asymmetry high frequency voltage, and the oxidation-reduction potential is lowering.

Fig. 14 shows a heat sink concerning the present invention, (a) is a perspective view of a molded component of the heat sink, and (b)~(d) are pattern cross sectional view of a heat sink material.

The heat sink concerning the present invention is comprised of plane base plate parts (7) and plural protuberant fin parts (8) which are located on the base plate parts (7) with spacing respectively.

Regarding a shape of the heat sink concerning the present invention, a shape of well known heat sink can be employed, and it is not limited the shape of the drawing. Therefore, thickness of the base plate parts (7), dimension, number of the fin parts (8), height and space etc can be changed based on installation space

and heat release ability.

The heat sink concerning the present invention can be obtained by fabricating the heat release sheet to the heat sink shape. All of above-mentioned sheets can be used as the heat release sheet, in this case, the thickness of the heat release sheet can be changed. Fig. 14 (b) shows the heat release sheet shown in Fig. 11 which is fabricated. Fig. 14 (c) shows the heat release sheet shown in Fig. 12 which is fabricated. Fig 14 (d) shows the heat release sheet shown in Fig. 13 which is fabricated.

A method of fabrication is not limited partsicularly, a method for forming the heat release sheet with using a metallic mold having an interior space of the desirable heat sink shape can be used suitably.

According to the heat sink which is fabricated the heat release sheet concerning the present invention, because of interlaminar abruption of graphite is difficult to occur and the heat conductivity to the direction to thickness occurs through the reticulated body comprised of the metal wire, the heat conductivity to the thickness direction is excellent.

Therefore, the heat sink that can efficiently and quickly release heat generating CPU used in electronic equipment such as a notebook computer and a portable telephone and semiconductor parts such as a power transistor etc.

Further, suitable rigidity is given to the sheet by the reticulated body comprised of the metal wire. Therefore,

formability and strength are excellent.

Fig. 15 shows an example of the heat release sheet and the heat sink concerning the present invention. In Fig. 15, the heat release sheet (10) is adhered on the surface of a semiconductor part (M) such as MPU mounted on substrate (K), and a heat sink (20) is located on the heat release sheet (10).

Heat generation from the surface of the semiconductor part (M) is transferred to the heat sink (20) through the heat release sheet (10), and from the heat sink (20), the heat is released to outside through a fan (F).

Hereinafter, an effect of the heat release sheet of the present invention is specified by showing an embodiment and a comparative example. However, the present invention is not limited to following embodiment.

1. Preparation of sample

(Embodiment)

The expansive graphite sheet (1) that thickness 0.15 mm, largeness 500 × 500 mm, density 1.65 g/cm^3, content ratio of graphite 99.7 % is used. The reticulated body (2) that a copper wire of diameter 0.12 mm is plain stitched so that 25 meshes in a dimension of 10 mm × 10 mm can be made is used. The heat release sheet having a configuration shown in Fig. 2 and 5 is obtained by metal rolling and combining the expansive graphite sheet (1) and the reticulated body (2) with using a metal rolling roll. The heat release sheet is used as a sample of the embodiment.

(Comparative example)

As a sample of the comparative example, the heat release sheet only comprised of the expansive graphite sheet (1) used in the embodiment is used.

2. Property evaluation

Heat conductivity (direction to plane and direction to thickness) and interlaminar abruption strength (interlaminar abruption of the graphite of expansive graphite sheet (1)) of the sample of the embodiment and comparative example were measured.

As a measuring method, heat conductivity was measured by μ flash. As interlaminar abruption, tensile shearing adhesive strength was measured by JIS-Z-0237 180° peel.

The result is shown in Table 2.

Table 2

	Unit	Embodiment	Comparative Example
Heat conductivity (direction to plane)	W/m℃ (W/mK)	560	260
(direction to thickness)	W/m℃ (W/mK)	23	3.6
Interlaminar abruption strength (tensile shearing adhesive strength)	MPa	0.38	0.012

As shown in the Table 2, compared to the sample of the comparative example, heat conductivity to direction to thickness of the sample of the embodiment was about 64 times and the

interlaminar abruption strength was about 32 times. From the result, the heat release sheet concerning the present invention is excellent in the heat conductivity to direction to thickness, that is excellent in heat release ability. Further, it is figured that interlaminar abruption of the sample of the embodiment is difficult occurred.

The heat release sheet of the present invention is preferably used for transferring heat generating from semiconductor parts on a substrate to a heat sink by adhering to the substrate mounting semiconductor parts of an electronic equipment such as a notebook computer and a portable telephone and by intervening between a multilayer board. Further, the heat release sheet is used for preventing partial temperature overheat in PDP by intervening between back glass plate of plasma display panel (PDP) of a plasma television and a chassis which supports the PDP. Moreover, the heat release sheet is used for cooling sputtering devise and dry etching devise.

The heat sink of the present invention is preferably used for efficiently release heat of the semiconductor parts etc transferred through the heat release sheet. Further, the present invention can be used as a heat connect medium to a heat pipe, which transmits heat generating from a heat source to a source for cooling such as a heat sink at a high speed (1000W/mk).